# ISLAM AND THE ORIGINS OF MODERN SCIENCES

By

KHWAJA ABDUL WAHEED

by

SAYYID ABUL A'LA MAUDUDI

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# ISLAM

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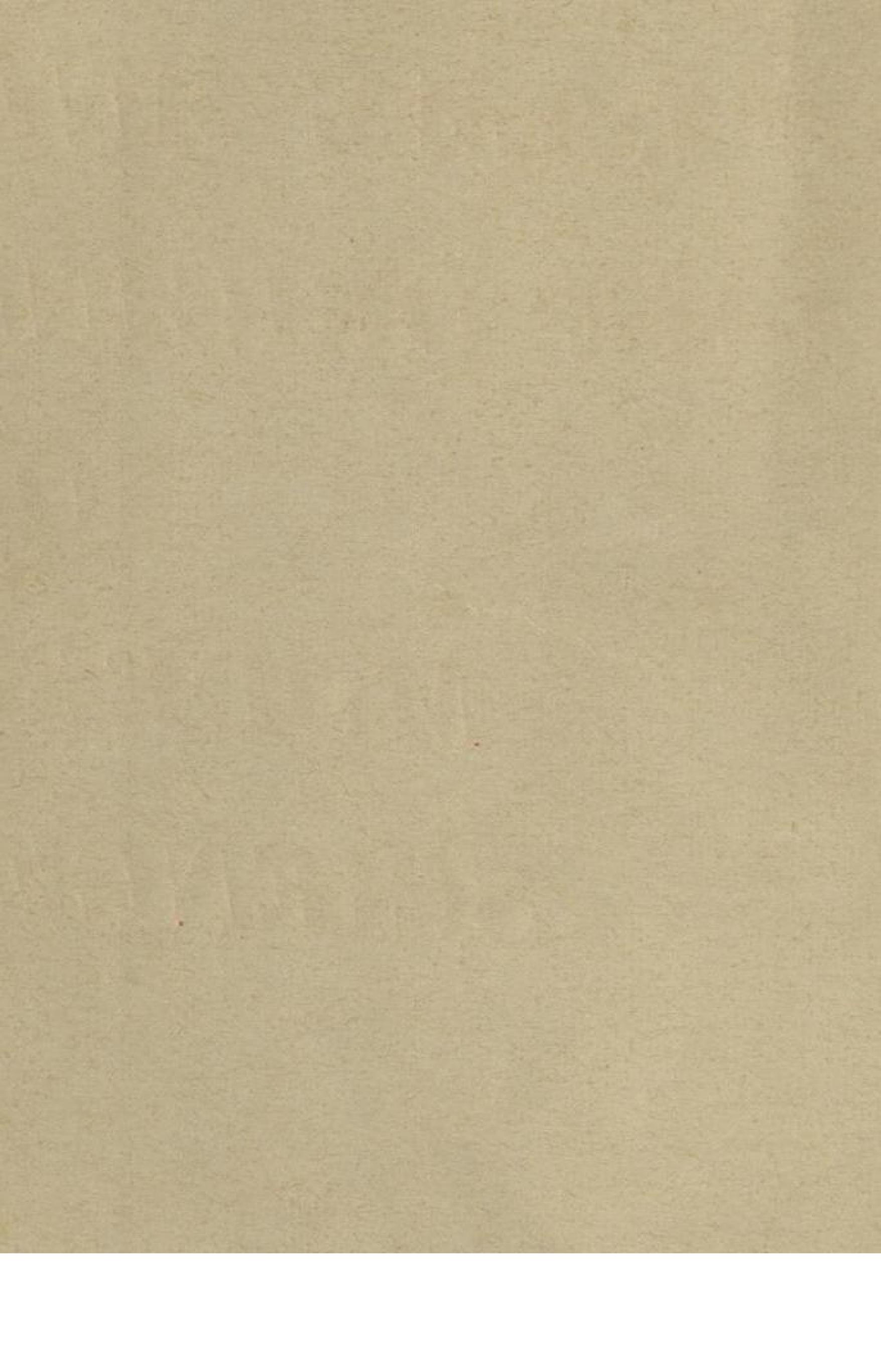
# The Origins of Modern Science


BY

**KHWAJA ABDUL WAHEED**



*Under the auspices of*

**Islamic Research Academy**

**Karachi**

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Islamic Research Academy, has been established in Pakistan (founded : Sept. 1963) for the purpose of organising and facilitating research on Islam, its ideology, history and culture and to present the unadulterated teachings of the Qur'an and Sunnah in the language of the modern times. The Academy proposes to combine the purely academic approach with a practical one and will endeavour to study Islam, not as a legacy of the dead past, but as an important living factor in the lives of six hundred million Muslims, capable of meeting the challenge of the modern times and destined to inaugurate a new era in the life of mankind. It is making a critical study of the nature and content of the western thought and culture and of their impact on the world of Islam. Its constant concern is to study and appraise the problems that confront the Muslims—statesmen, intellectuals and laymen alike—in this crucial phase of their history and to re-interpret their tradition in such a manner that they may not only be able to catch a glimpse of their past but also to imbibe at the wells of the original sources of Islam, have a clear vision of the ideas and v... this that the Muslims have lived by, and be enab... are chart a way for themselves out of the pres... only a part

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the Academy are exempted under LXX 15-D of Income Tax Act 1922 (Gazette of the Government of Pakistan, S.R.O. 1226 (K) 66). Its major research establisment is located at Karachi and two smaller units are working at Lahore and Dacca. The research organisation is being gradually expanded and organised under four departments viz : (i) Law and Jurisprudence (ii) Economics and Sociology (ii) Islamic History and Culture and (iv) Pakistan Studies. An effort is being made under the aegis of the Academy to bring together scholars who have been educated under traditional as well as those who have been educated under the modern educational systems.

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## FOREWORD

There is a tendency in certain academic circles to allege that Islam is opposed to science. This allegation is a product of ignorance, prejudice and even malice. Those who are ignorant of the history of Islam and its scientific accomplishments vainly assume that the record of the religion of Muhammad (peace be upon him) would not be very dissimilar to that of the Christian church in the medieval times. This is a grossly mistaken view of the situation and facts abundantly contradict it. Those who are prejudiced or who act out of malice refuse to see the obvious and acknowledge the apparent. They would find fault with others even when there is none. They would not be prepared to submit before facts, save when totally out-witted. The Islamic Research Academy is preparing a book on *Islam and Science* which shall contain all the necessary information on this subject and thus expose the falsity of this allegation. As a prelude to that major work we are publishing this brochure which contains only a part of one of the chapters of the said book. This is intended to meet the pressing needs of those students and workers of Islam who are being confronted with such allegations by the Christian missionaries and the Communist propagandists. This is a fully documented rebuttal of the allegation and shows how

Islam released the forces which gave birth to modern science. Of course our reference is to the methods, techniques and facts of science and not to the conflicting philosophies of science which have been developed in the Modern West in a cultural environment that was antagonistic to religion and moral values, in a climate that was highly sensate, amoral and this worldly. And it is the later which has not only detracted from the utility of science but has on many an occasion made it an instrument of destruction.

In this brochure we have not entered into any philosophical discussion on the old controversy about the conflict of religion and science and have confined ourselves to the basic Islamic attitudes and their flowering in history. The book which we propose to publish will cover all relevant aspects, here we are dealing only with one aspect of the problem.

This brochure is culled out of a lengthy article of Khwaja Abdul Waheed on the 'Islamic Origins of Modern Science,' which will be included in the book under preparation. We, however, hope this will be read with interest and profit. Our heartfelt thanks are due to Khwaja Sahib for his unstinted cooperation with the Academy.

Karachi
1st March, 1967.

KHURSHID AHMAD
Secretary-General.

# ISLAM

# AND

# THE ORIGINS OF MODERN SCIENCE

SCIENCE is "the ordered knowledge of natural phenomena and the relations between them" and "its end is the rational interpretation of the facts of existence as disclosed to us by our faculties and senses." In the words of Sir. J. Arthur Thomson, "Science is the well-criticised body of empirical knowledge declaring in the simplest and tersest terms available at the time what can be observed and experimented with, and summing up uniformities of change in formulae which are called laws verifiable by all who can use the methods". The hypotheses of Science, according to another great scientific thinker, Karl Pearson, are formed on the "basis of the observed facts, which, when confirmed by criticism and experiment, are turned into the Laws of Nature" (*The Grammar of Science*).

The first step, therefore, towards scientific achievement is that of observation and experiment. It was by introducing this step of observation and experiment that the followers of Islam gave Science its true characteristic which the pre-Islamic world was utterly unaware of.

## PRE-ISLAMIC WORLD

Modern Science is said to be the child of Greek Science and the Renaissance is believed to have been brought about mainly by the restoration of the Greek classics. But a deeper study of the history of intellectual development goes to prove the futility of this view. H. G. Wells says in his *Outline of History:*

"The thought of the Greeks was hampered by a want of knowledge that is almost inconceivable to us to-day. They had no knowledge of the past of mankind at all, they had no knowledge of geography beyond the range of the Mediterranean basin and the frontiers of Persia. Their astronomical ideas were still in the state of rudimentary speculation. The forty-seventh proposition of the first book of Euclid was regarded as one of the supreme triumphs of the human mind. One has to remember their extraordinary poverty in the matter of experimental apparatus. They had no accurate means of measuring the minor intervals of time, no really efficient numerical notation, no very accurate scales, no rudiments of telescope or microscope."

Prof. A. N. Whitehead says in *Science and the Modern World:* "The Greeks were over-theoretical, for their science was an offshoot of philosophy ......The Greek genius was philosophical, lucid and logical. The men of this group were primarily asking philosophical questions. Their minds were

infected with an eager generality. They demanded clear, bold ideas, and strict reasoning from them. All that was excellent ; it was genius ; it was ideal preparatory work. But it was not science as we understand it."

The whole intellectual work of Greece was abstract. According to Oswald Spengler, "the Greek did not stay his course for such base purpose as the careful investigation and collation of facts, he saw them and rushed to create by pure insight or philosophy a theory of the universe. The Greek, throughout his culture, preferred abstract thought to the study of concrete facts. Almost careless of external facts the Greek was free to devote himself to the world of thought." (*The Decline of the West*). And again : "What for us is the way to acquire experience is for the Greek the way to lose it. And therefore he kept away from the drastic method of experiment."

Not only the Greek but the whole of the ancient science was lacking in experimental verification. "Everywhere, where what was needed was the attainment, by the variation and combination of observations, to the discovery of laws, the ancients remained in a backward condition. To the idealist was lacking the sense for and interest in concrete phenomena ; the Materialists were always too much inclined to stop short with a single observation, and to content themselves with the first explanation that offered itself, instead of probing the matter to the bottom." (Lange : *The History of Materialism*).

And here a few words may be appropriately quoted about the ancient Romans. Max Kahn observes in Chap. I on "History of Ancient Medicine" in Vol. I of the *Practice of Medicine*: "The Byzantine period was particularly sterile in its contribution to knowledge. In medicine and in philosophy strict adherence to the teachings of the orthodox school was enforced. There was no independent thought, no search for new paths, no original investigations. Again in the absence of learning, superstition held supreme sway, alchemy flourished, and astrology and mysticism were in vogue."

During the Dark Ages, which extended over Europe from the fifth to the tenth centuries A.D., the peoples of that continent were living in a highly savage state. They were "unclean in person, benighted in mind." Their moral codes were degraded and their theology debased. Indeed, "the degradation of the human intellect during this period was most widespread over Europe" (Ch. Singer: Chapter on "The Dark Ages and Dawn" in *Science and Civilization*).

Throughout the Dark Ages in Europe Science lay in obscurity and subordination. Its public existence was not tolerated. Every material phenomenon was attributed to the will of a spirit. Everywhere there was want of reasoning, want of thinking, want of looking into things. Ideas in all spheres of life were based on superstitious grounds. The average European, "fever-stricken or overtaken by accident, ran to the nearest saint-shrine to be cured by a miracle."

Under the influence of Byzantine rule, there was in Europe, to be found "an almost universal reliance on miraculous intervention" for the cure of disease. John William Draper says in Volume I of his *History of the Intellectual Development of Europe :*

"Never was a more disastrous policy adopted than the Byzantine suppression of profane learning. It is scarcely possible now to realize the mental degradation produced when that system was at its height. Many of the noblest philosophical and scientific works of antiquity disappeared from the language in which they had been written...The insolent assumption of wisdom by those who held the sword crushed every intellectual aspiration."

Draper observes in his book already quoted :

"From the barbarism of the native people of Europe, who could scarcely be said to have emerged from the savage state, unclean in person, benighted in mind, inhabiting huts in which it was a mark of wealth if there were bulrushes on the floor and straw mats against the walls ; miserably fed on leaves, vetches, roots, and even the bark of trees ; clad in garments of untanned skin, or at the best of leather—perennial in durability but not conducive to personal purity—a state in which the pomp of royalty was sufficiently and satisfactorily manifested in the equipage of the sovereign, an ox-cart, drawn by not less than two yokes of cattle, quickened in their movements by the goads of pedestrian serfs, whose legs were wrapped in

wisps of straw ; from a people, devout believers in all the wild fictions of shrine-miracles and preposterous relics ; from the degradation of a base theology, and from the disputes of ambitious ecclesiastics for power, it is pleasant to turn to the south-west corner of the continent, where under auspices of a very different kind, the irradiations of light were to break forth."

## ISLAM

That light was to be shed by the Crescent of Islam. "When Europe was hardly more enlightened than Cafraria is now, the Saracens were cultivating and even creating science. Their triumphs in philosophy, mathematics, astronomy, chemistry, medicine, proved to be more glorious, more durable and, therefore, more important than their military actions had been."

When the great Prophet of Islam was born, "the majority of Mankind looked upon the elements of Nature, the subject-matter of science, as objects possessing supernatural powers. They made idols, symbolizing different elements, and worshipped them as gods and goddesses, either for protection from evil or for attainment of certain objects. Thus were the sun, the moon, the stars, air, water, animals and even trees and stones deified and adored. It was nothing unnatural in such circumstances that any deviation from the prevailing belief in their sanctity should have been branded as sacrilege, and any attempt at a

critical examination of their potentiality, for good or evil, stigmatized as profane. Thus all that was useful in the heavens and the earth remained altogether unexplored, and for thousands of years Man did not realize the sublime utility of the forces of Nature. It was reserved for the Book of Islam to open Man's eyes to the wonderland of Nature by bringing down her elements from the high pedestal of divinity, on which they had been placed by Man, to the position of servants of Mankind." Says the Holy Qur'an:

> "And He has made subservient for you the night and the day, and the sun and the moon, and the stars are made subservient by His commandment; most surely there are signs in this for a people to ponder." (16:12)

"Thus were the gods of the pre-Islamic peoples reduced by one stroke to Man's servants. For the first time in the history of the world the Book of Islam declared in unmistakable terms, that the main purpose for which all natural objects, from the mightiest stars to the most insignificant atoms, were created is to minister to Man's needs. Everything in the universe being intended for his use, Man has been commanded to investigate their intrinsic properties. The initiation of the conquest of Nature and the utilization of its forces for the good of humanity is, indeed, one of the greatest blessings Islam has conferred upon Mankind." (Moulvi Abdul Karim: *Islam's Contribution to Science and Civilization*).

**Basic Approach**

As the late Dr. Sir Muhammad Iqbal has pointed out, for the purpose of knowledge the spirit of Islamic Culture fixes its gaze on the concrete, the finite. It is, indeed according to him, the intellectual capture of and "power" over the concrete that makes it possible for the intellect of man to pass beyond the concrete. The Book of Islam, therefore, produced a concrete spirit in the mind of man as against the speculative spirit of ancient Greece, and that spirit created a revolt in the Muslim mind against the Greek thought which ignored all observation and experiment. This revolt, which laid the foundations of modern science, "manifests itself in all departments of human thought".

The Book of Islam introduced into the world the idea of Law and Order in Nature, ascribed natural phenomena to material causes, infused a spirit of rational thought, encouraged a first-hand study of Nature by observation and experiment, produced a universal longing for scientific inquiry by encouraging "taffaquh", "tafakkur", and "taaqqul"; and thus paved the way to the true understanding of Nature and natural phenomena.

That there is everywhere in nature Law and Order and no chaos, that the universe is working according to a definite plan destined to progress up to a certain goal, is proclaimed in verses like the following:

"And the Sun hasteneth to her place of rest, this is

the ordinance of the Mighty, the Knowing. And as for the Moon, We have decreed stations for it till it changeth like an old and crooked palm branch. To the Sun it is not given to overtake the Moon, nor does the night overstrip the day; but each in its own sphere doth journey on."

(36 : 33-40)

And

"With Him everything is by measure." (13 : 8)

These two verses clearly show that the working of nature is regulated by fixed laws. In this connection we would invite a reference to the first verse of the Holy Book (الحمد لله رب العلمين) 'All praise is due to Allah, the Lord of the worlds'. The word 'Rabb', which is usually translated as 'Lord' literally means 'one who brings everything gradually to perfection', which shows that the creation of the universe is an affair organized on a definite plan and proposed to run on to a goal in a definite order.

The first verse quoted above contains the words "To the Sun it is not given to overtake the Moon, nor does the night overstrip the day", which give the idea that the laws of nature are not changeable. There are definite declarations on this point in the Qur'an, *e.g.*,

"For you shall never find any alteration in the course of God; and you shall never find any change in the course of God." (35 : 43)

"And there is none to change the words of God."

(6 : 44)

The Qur'an thus declared at the beginning of the Dark Ages in Europe that (1) the universe was working under certain laws and that (2) those laws were unchangeable, and thus laid the basis for all scientific research. The next step was to see things and think about them by doing which alone the laws of nature could be ascertained.

### The Use of the Senses and the Reasoning Faculty

The Qur'an has encouraged the use of the senses in words both beautiful and forceful. Its followers are required to see things for themselves, to go about the world and observe what is going on around them. Persons who act according to this advice are promised great and lasting rewards, and those who do not act accordingly are condemned very strongly. A verse of the 25th Chapter runs as follows:

> "And they who, when reminded of the communications of their Lord, do not fall thereat deaf and blind." (25: 73)

These words require one to think over things and not to take them as granted. We come across words like the following many a time in the Book:

> "Do they not meditate on the (contents of the) Qur'an?" (4: 82)

A verse of the 7th Chapter, called the "Sura-i-A'raf", contains the words:

> "They have minds but do not ponder by them, and they have eyes but do not see by them, and they have ears but do not hear by them. They

are like the cattle—rather worse than the cattle—
they are the negligent." (7 : 179)

The words "they are the negligent" clearly imply that they who do not use their senses are neglecting an important duty. And there are to be found in the Book words still more forceful than these :

"Verily, the vilest of creatures with God are the deaf and dumb who do not understand". (8 : 22)

We wonder if the use of the senses and reason can be encouraged in words stronger than these.

## OBSERVATION

One is required by the Book of Islam to observe the various natural phenomena taking place all round in words like the following :

"Do they not look towards the camel how it is created, and the Heaven how it is raised, and the Mountains how they are fixed, and the Earth how it is spread ?" (81 : 17-20)

"Most surely, in the variation of the night and the day and what Allah has created in the Heavens and the Earth, there are signs for a people who think." (10 : 6)

These words clearly encourage the observation of natural phenomena. And phenomena of all sorts are required to be studied, as is obvious from the verses like the one quoted below :

"Assuredly in the creation of the Heavens and the Earth ; and in the alternation of the night and the day ; and in the ships which pass through the

sea with what is useful to men, and in the rain which God sendeth down from Heaven, giving life by it to the Earth after its death, and scattereth over it all kinds of cattle, and in the change of winds and in the clouds that are made to do service between the Heaven and Earth—there are signs for those who understand." (2 : 159)

The study of archaeological remains is encouraged in words like the following which occur in the 30th Chapter:

"Have they not travelled in the Earth and seen the end of those before them ?" (30 : 9)

In the 16th Chapter there are verses which require us to observe the animal world with a view to finding the various purposes which it can serve:

"And most surely there is a lesson for you in the cattle. We give you to drink and what is in their bellies—from betwixt the faeces and the blood—pure milk, easy and agreeable to swallow for those who drink." (16 : 66)

"And He has given you tents of the skins of cattle which you find light to carry on the day of your march and on the day of your halt, and of their wool and their fur and their hair (He has given you) household stuff and a provision for a time." (16 : 80)

Attention is invited to the diversity of tongues and races in words like the following:

"And one of His signs is the creation of the Heaven and the Earth and diversity of tongues and races.

Most surely there are signs in this for the knowing." (30 : 32)

The study of the clouds is encouraged in words like the following :

"Do you not see that God drives along the clouds, then gathers them together, then piles them up so that you see the rain coming forth from their midst ?" (24 : 43)

The above verses directly enjoin upon the reader to study natural phenomena. There are other verses also to be found in the Qur'an throwing light on the same subject. For instance :

"And in the mountains are streaks, white and red, of various hues and (others) intensely black." (25 : 27)

"He it is who made the Sun a shining brightness and ordained for it mansions that you might know the computation of years and the reckoning." (10 : 5)

"He creates you in the wombs of your mothers—a creation after a creation, in triple darkness." (39 : 6)

And here may be quoted a verse of the 3rd Chapter which declares that those persons are the wise who study natural phenomena and think over questions like the birth and evolution of the universe:

"Most surely in the creation of the Heavens and the Earth and the alternation of the night and the day there are signs for the wise—who remember God standing and sitting and lying on their sides

and reflect on the creation of the Heavens and the Earth." (3 : 189-190)

In this verse the epithet 'wise' has been applied to those who 'reflect on the creation of the Heavens and the Earth'. We do not think that the study of nature and the observation of natural phenomena can be encouraged in a way more beautiful than this.

## EXPERIMENT

There is a verse of eight words in the 2nd Chapter of the Qur'an which is the key to all scientific research. It runs as follows:

"He it is Who created for you all that is in the Earth." (2 : 28)

This single verse shows that (1) everything on the earth is for Man's use, (2) he should bring into his use everything he requires, (3) which cannot be done until the use of everything is known. There is another verse in the 30th Chapter saying :

"And you shall be questioned on that day as to His favours." (102 : 7)

that is, it will be judged whether everything which fell into the possession of Man was put to the right use by him. Combining the two verses we draw the conclusion that we should, in order to gain the puspose of creation, ascertain the uses to which the mineral, vegetable and animal kingdoms can be put. It is clear, further, that an attempt to do the same would result in the development of the different branches of Science which deal with the nature and

properties of things in their different aspects. Again, we are told in the 5th Chapter :

"And We have made Iron wherein is great violence and advantages to men." (57 : 25)

which shows that Iron can and should be brought into use to do which the Science of Mineralogy must be developed.

A verse of the 16th Chapter refers to the medicinal properties of honey in the following way :

"In it (there) is healing for men." (16 : 69)

which clearly shows that Man is expected to investigate the properties of the various substances of medicinal value. This obviously encourages the study of Medicine which one cannot take up unless he is well versed in all the sciences like Physics, Chemistry, Biology and Anatomy. A verse of the 23rd Chapter reads as follows :

"And certainly We created man of an extract of clay. Then We made him a small life-germ in a firm resting-place. Then We made the life-germ a clot. Then We made the clot a lump of flesh, then We made (in) the lump of flesh bones, then We clothed the bones with flesh, then We caused it to grow into another creation. So blessed be Allah, the best of the creators." (23 : 12-24)

What a beautiful way of encouraging the study of *intra-uterine* development of Man which is the subject-matter of Embryology.

The fourth section of the second Chapter of the Qur'an contains an account of the creation of Man

which throws much light on our subject. In fact if the true sense of this part of the Book were understood clearly, there would be left no doubt as to the importance of scientific research by means of observation and experiment. We cannot help quoting a major portion of the section in question:

> "When thy Lord said to the angels, 'Verily, I am about to place one in My stead on earth,' they said, 'Wilt thou place there one who will do ill therein and shed blood, when we celebrate Thy praise and extol Thy holiness'?
>
> "And He taught Adam the names of all things and then set them before the angels, and said, 'Tell Me the names of these, if you are endued with wisdom.'
>
> "They said, 'Praise be to Thee, we have no knowledge but what Thou hast given to us to know Thou, Thou art the Knowing, the Wise'.
>
> "He said, 'O Adam! inform them of their names.' And when he had informed them of their names, He said, 'Did I not say to you that I know the hidden things of the Heavens and of the Earth, and that I know what ye bring to light and what ye hide'?"

From the above verses it follows that:

(*i*) Man was created to be the over-lord on the Earth.

(*ii*) The one qualification which entitled him to this over-lordship was the knowledge of things.

(*iii*) In order to qualify himself for overlordship Man must obtain the knolwedge of things.

(*iv*) Man must develop the various branches of knowledge, the sciences dealing with the nature and properties of things.

It is clear from the above that the one thing which makes Man an overlord is scientific knowledge ; and, of course, history has proved it to be a fact. Those nations only can survive who can utilise the hidden forces of Nature in a more effective way, that is, who are more advanced in the practical application of their scientific knowledge.

Every cause has an effect and one is, therefore, justified in enquiring what were the practical results of the above teachings which, we have claimed, were imparted by the Qur'an.

## LEADERS OF MEDIEVAL LEARNING

That throughout the Middle Ages the pursuit of science and intellectual activity were things purely Islamic is proved by very strong historical evidence. "The language of the Qur'an became the international vehicle of scientific progress". Every new scientific theory, every new discovery was published in Arabic. Even Jews and Christians were writing their scientific works in that language. "While Christian Oxford was trying to digest the first five propositions of the first book of Euclid, Moslem Cordova and Toledo were working out spherical trigonometry and the theory of numbers".

Whoever in Europe tried to popularise knowledge and diffuse culture was considered to be a Muslim and treated as such by Christian Europe. Roger Bacon was called "Mohammadan" on account of his scientific activities and awarded a sentence of fourteen years' imprisonment. Luther, who brought about far-reaching changes in religion, bringing forth the Reformation, was also accused of being a Muslim. Whoever wanted to learn the elements of a science like Physics, Chemistry, Astronomy or Medicine had no course open to him except to go to Muslim Spain to study under the direction of Muslim teachers. And it was the Book of Islam which brought about all this intellectual transformation.

## ENLIGHTENMENT AND CULTURE

Writing about the intellectual and cultural advancement of Spain under Muslim Rule, Draper observes in his *History of the Intellectual Development of Europe* (Vol. II) :

> "Scarcely had the Arabs become firmly settled in Spain when they commenced a brilliant career. Adopting what had now become the established policy of the commanders of the faithful in Asia, the Emirs of Cordova distinguished themselves as patrons of learning and set an example of refinement strongly contrasting with the condition of native European princes. Cordova, under their administration at its highest point of prosperity, boasted of more than two hundred thousand

houses, and more than a million inhabitants. After sunset, a man might walk in a straight line for ten miles by the light of public lamps. Seven hundred years after this time there was not so much as one public lamp in London. Its streets were solidly paved. In Paris, centuries subsequently, whoever stepped over his threshold on a rainy day stepped up to his ankles in mud." Stanley Lane-Poole says in his well-known work *Moors in Spain:*

"For nearly eight centuries under her Mohammadan rulers, Spain set to all Europe a shining example of a civilized and enlightened state..., Arts, literature, and science prospered as they then prospered nowhere in Europe. Students flocked from France and Germany and England to drink from the fountain of learning which flowed only in the cities of the Moors. The surgeons and doctors of Andalusia were in the van of science; women were encouraged to devote themselves to serious study, and the lady doctor was not always unknown among the people of Cordova. Mathematics, Astronomy, and Botany, History, Philosophy and Jurisprudence were to be mastered in Spain, and Spain alone. The practical work of the field, the scientific methods of irrigation, the arts of fortification and shipbuilding, the highest and most elaborate products of the loom, the gravel and the hammer, the potter's wheel and the mason's trowell, were brought to

perfection by the Spanish Moors. Whatsoever makes a kingdom great and prosperous, whatsoever tends to refinement and civilization, was found in Moslem Spain."

## PASSION FOR LEARNING

Another historian observes:

"The incorruptible treasures and delights of intellectual culture were accounted by the princes of Baghdad, Shiraz and Cordova, the truest and proudest pomps of their courts. But it was not as a mere appanage of princely vanity that the wonderful growth of Islamic science and learning was fostered by their patronage. They pursued culture with the personal ardour of an overmastering craving. Never before and never since, on such a scale, has the spectacle been witnessed of the ruling classes throughout the length and breadth of a vast Empire given over entirely to a frenzied passion for the acquirement of knowledge. Learning seemed to have become with them the chief business of life. Khalifs and Emirs hurried from their diwans to closet themselves in their libraries and observatories; they neglected their affairs of state to attend lectures and converse on mathematical problems with men of science; caravans laden with manuscripts and botanical specimens plied from Bokhara to the Tigris, from Egypt to Andalusia; embassies were sent to Constantinople and to India for the sole purpose of obtaining books and teachers; a collection of Greek authors

or a distinguished mathematician was eagerly demanded as the ransom of an empire. To every mosque was attached a school; wazirs vied with their masters in establishing public libraries: endowing colleges, founding bursaries for impecunious students. Men of learning, irrespective of race or religion, took precedence over all others; honours and riches were showered upon them; they were appointed to the government of provinces; a retinue of professors and a camel-train of books accompanied the Khalifs in their journeys and expeditions".

## SCIENTIFIC ACTIVITY IN THE ISLAMIC WORLD

Still another historian has observed:

"And a century or so in advance of the West, there grew up in the Muslim world at a number of centres, at Basra, at Kufa, at Baghdad and Cairo, and at Cordoba, out of what were at first religious schools dependent upon mosques, a series of great universities. The light of these universities shone far beyond the Muslim world, and drew students to them from east and west. At Cordoba in particular there were great numbers of Christian students, and the influence of Arab Philosophy coming by way of Spain upon the universities of Paris, Oxford and North Italy and upon Western European thought generally, was very considerable indeed. The name of Averroes (Ibn Rushd) of Cordoba (1126-1198) stand out as that of the culminating influence of Arab philosophy upon

European thought. Another great name is that of Avicenna (Ibn Sina), the Prince of Physicians (980-1037) who was born at the other end of the Arabic world at Bokhara, and who travelled in Khorasan... The book-copying industry flourished at Alexandria, Damascus, Cairo and Baghdad and about the year 970 there were twenty-seven free schools open in Cordoba for the education of the poor".

"In Mathematics", say Thatcher and Schwill in *A General History of Europe*, "the Arabs built on the foundations of the Greek mathematicians. The origin of the so-called Arabic numerals is obscure. Under Theodoric the Great Boethius made use of certain signs which were in part very like the nine digits which we now use. One of the pupils of Geber also used signs which were still more like ours, but the zero was unknown till the twelfth century, when it was invented by an Arab mathematician named Muhammad ibn Musa, who also was the first to use the decimal notation, and who gave the digits the value of position. In Geometry the Arabs did not add much to Euclid, but Algebra is practically their creation: also they developed spherical trigonometry, inventing the sine, tangent, and cotangent. In Physics they invented the pendulum, and produced works on optics. They made progress in the sciences of Astronomy. They built several observatories, and constructed many astronomical instruments which are still in use. They calculated the angle of the ecliptic and the precession of the equinoxes. Their knowledge of Astro-

nomy was undoubtedly considerable".

Speaking of Muslim influence in Spain, Winwood Reade says in the *Martyrdom of Man*:

"At a time when books were so rare in Europe that the man who possessed one often gave it to a church, and placed it on the altar, *pro remedio animae sua*, to obtain remission of his sins; at a time when three or four hundred parchment scrolls were considered a magnificent endowment for the richest monastery; when scarcely a priest in England could translate Latin into his mother tongue; and when even in Italy a monk who had picked up a smattering of Mathematics was looked upon as a magician, here was a country in which every child was taught to read and write; in which every town possessed a public library; in which book-collecting was a mania; in which cotton and afterwards linen paper was manufactured in enormous quantities; in which ladies earned distinction as poets and grammarians; and in which even the blind were often scholars; in which men of science were making chemical experiments, using astrolabes in the observatory, inventing flying machines, studying the Astronomy and Algebra of Hindustan".

## CHARACTERISTICS OF MUSLIM SCIENTISTS

The great merit of the scientists of Islam is this that, led by the inquiring spirit of the Qur'an, they, for the first time in human history, realized that "Science could not be advanced by mere speculation;

its only sure progress lay in the practical interrogation of Nature. The essential characteristics of their method are experiment and observation. In their writings on Mechanics, Hydrostatics, Optics, etc., the solution of a problem is always obtained by performing an experiment, or by an instrumental observation. It was this that made them the originators of Chemistry, that led them to the invention of all kinds of apparatus for distillation, sublimation, fusion, filtration, etc.; that in Astronomy caused them to appeal to divide instruments, as quadrant and astrolabe; in Chemistry to employ the balance, the theory of which were perfectly familiar with ; to construct tables of specific gravities and astronomical tables; that produced their great improvements in Geometry, Trigonometry, the invention of Algebra, and the adoption of the Indian numeration in Arithmetic".

## THE RENAISSANCE IN EUROPE

The Renaissance, or Revival of Learning, began in Europe at the dawn of the fourteenth century, A. D. This fourteenth-century Renaissance was an offspring of Muslim culture. "When at the Renaissance," says Robert Briffault in *The Making of Humanity*, "the spirit of man was once again filled with the zeal for knowledge and stimulated by the spark of genius, if it was able to set promptly to work, to produce and to invent, it was because the Arabs had prescribed and protected various branches of knowledge, kept the spirit of research alive and eager, and maintained

it pliant and ready for future discoveries".

Dr. Thorndike says in *Mediaeval Europe:*

"If the Arabs had defeated Charles Martel and the Franks, whose kingdoms were actually to collapse in any case, and if they had over-run Western Europe as they did the Spanish Peninsula, Euorpean civilization might have revived the more quickly".

Robert Briffault says:

"It was under the influence of Arabian and Moorish revival of culture, and not in the fifteenth century, that the real Renaissance took place. Spain, not Italy, was the cradle of the rebirth of Europe. After steadily sinking lower and lower into barbarism, it had reached the darkest depths of ignorance and degradation when the cities of the Saracenic world Baghdad, Cairo, Cordoba, Toledo were growing centres of civilization and intellectual activity. It was there that new life arose which was to grow into a new phase of human evolution. From the time when the influence of their culture made itself felt, began the stirring of a new life. The fact has been set forth again and again. But it has been nevertheless stubbornly ignored and persistently minimised." (*The Making of Humanity*).

And again,

"It is highly probable that but for the Arabs modern European civilization would never have arisen at all; it is absolutely certain that but for them, it would not have assumed that character which has enabled it to transcend all previous phases of

evolution. For although there is not a single aspect of European growth in which the decisive influence of Islamic culture is not traceable nowhere is it so clear and momentous as in the genesis of that power which constitutes the paramount distinctive force of the modern world and the supreme source of its victory—natural science and the scientific spirit." (*The Making of Humanity.*)

And lastly:

"The debt of our science to that of the Arabs does not consist in startling discoveries or revolutionary theories; science owes a great deal more to Arab Culture, it owes its existence. The ancient world was, as we saw, prescientific......what we call science arose in Europe as a result of a new spirit of enquiry, of new methods of investigation, of the methods of experiment, observation, measurement, of the development of mathematics in a form unknown to the Greeks. That spirit and those methods were introduced into the European world by the Arabs."

## INFILTRATION OF ISLAMIC LEARNING INTO EUROPE

George Sarton in the first volume of his monumental work *Introduction to the History of Science* says:

"When the West was sufficiently mature to feel the need of deeper knowledge, when it finally wanted to renew its contacts with ancient thought, it turned its attention first of all, not to the Greek sources, but to the Arabic ones."

The first step taken by the European nations towards scientific advancement was to acquire the learning of the Muslim world, the next to translate it into the various languages of Europe. (In the course of translation some works were intentionally or otherwise, ascribed to the translators themselves). The third step, in this connection, was the incorporation of Islamic learning into books written in European languages with the consequence that some of the original works of the Muslim scientists were attributed again to European scientists who were in fact simply borrowers from Islamic sources. For instance, Sacrobosco (John of Holyhood) had drawn the material for his book (*De Sphere Mundi*) from al-Battani (Albetegnius of Europe), but the thing was ascribed to Ptolemy. According to the *Historians' History* it was from Ibn al-Haitham's Twilight that the illustrious Kepler took his ideas of atmospheric refraction; "and it may be that Newton himself owes to the Arabs, rather than to the apple in his archarat at Woolsthorpe, the first apperception of the system of the universe, for Mohammad Ben Musa seems, when writing his books on the movement of the celestial bodies and on the Force of Attraction, to have had an inkling of the great law of general harmony".

## RISE OF EDUCATIONAL INSTITUTIONS IN EUROPE

While discussing the rise of universities in Europe

in the second half of the twelfth century A.D. George Sarton tells us in Vol. II of the *Introduction to the History of Science* that the "amount of Greco-Arabic knowledge which had reached the West by the end of the twelfth century was already so large that systematic methods of education became necessary. The universities could not appear earlier because there had not been sufficient scope nor opportunity for them until that time, and they appeared then because the need was suddenly urgent then." Sarton concludes that "nothing can better illustrate the intellectual revolution caused in the Christian West by the sudden transmission of Greco-Arabic culture".

## ROGER BACON

The two greatest fore-runners of the Revival were Roger Bacon and the Crusades, Roger Bacon introduced the experimental method in Science and the Crusades "brought new ideas to Europe which enlarged the mental horizon of the youth of Christian Europe and assisted in preparing the way for the Renaissance."

Long before Bacon was born the world had seen a vast system of observations and experimental research going on in the observatories and laboratories which were spreading over the Islamic world from Spain to Mesopotamia, wherein patient workers had been working for a long time to find out the mysteries of Nature.

Bacon was born in 1214 A.D. and by that time the

scientific achievements of the Muslims had penetrated into Europe. It is also a fact that whatever Bacon achieved in the domain of science had its origin in Muslim learning as is evident from the fact that "the school at Oxford where he was educated had been established for the propagation of Muslim science by the Jews who had been driven out of Spain by the Christians and reached England with William of Normandy". It is further a fact that Roger had had education in many continental seats of Islamic learning because in his time nowhere else in Europe was scientific knowledge obtainable.

Robert Briffault says in *The Making of Humanity:*

"Neither Roger Bacon nor his later name-sake has any title to be credited with having introduced the experimental method. Roger Bacon was no more than one of the apostles of Muslim science and method to Christian Europe, and he never wearied of declaring that a knowledge of Arabic and Arabian science was for his contemporaries the only way to true knowledge. Discussions as to who was the originator of the experimental method like the fostering of every Arab discovery or invention on the first European who happens to mention it, such as the invention of compass to a fabulous Falvio Goija of Amalfi, of alcohol to Arnold of Villenseuve, of lenses and gun-powder to Bacon or Schwartz, are part of the colossal misrepresentation of the origin of European civilization. The experimental method of the Arabs

was by Bacon's time widespread and eagerly cultivated throughout Europe, it had been proclaimed by Adelard of Bath, by Alexander of Neckam, by Vincent of Beauvais, by Arnold of Villenseuv, by Bernard Sylvestris."

That what Roger Bacon achieved was something of Islamic origin is evident from the fact that he was accused of being a Muslim on account of his scientific activities. Says White:

"Another weapon was also used upon the battlefield of science in that time with much effect. The Arabs had made very noble discoveries in science, and Averroes had in the opinion of many divided the honours with St. Thomas Aquinas: this gave the new missile. It was the epithet 'Muhammadan'. This, too, was flung with effect at Bacon."

We learn from the Article "Roger Bacon" in the *Encyclopedia Britannica* that "it is beyond all doubt that Roger Bacon was profoundly versed in Arabian learning and derived from it many of the germs of his philosophy".

## HISTORICAL EVIDENCE

That Arabian learning had fully penetrated into Europe by the time of Roger Bacon is obvious when facts like the following are taken into consideration. Adelard of Bath (c. 1100) had, already by this time, translated from Arabic, besides other works, (1) The Astronomical Tables of al-Khawarizmi, (2) Euclid's

Elements, and (3) Astrological Treatise of Abu Ma'shar Ja'far. He had also left a Dialogue of 76 chapters explaining what he had learnt from the Arabs. Harmann of Corinthia had translated Ptolemy's *Planisphere* based on the Arabic Text of Maslama. The *Optics* of Ptolemy had been translated into Latin from the Arabian version about the year 1150 by Eugenis of Palermo. *Almagest*, Ptolemy's greatest work, which had been known through the translated version of al-Farghani, had passed into Europe through the translation from Arabic which Gerard of Cremona (1114-1187) completed at Toledo in 1175. This Gerard translated no less than ninety-two complete Arabic works, among them being the *Qanun* of Ibn Sina.

Michael Scott and Theodore of Antioch had made versions of Arabic works on Zoology. Al-Bitruji's work on the Sphere had also been translated by the former. Hugo Sanctellensis had translated a meteorological work of Abu Ma'shar Ja'far and two treatises of Maashaallah and Al-Kindi. Robert of Chester had translated the *Algebra* of al-Khawarizmi, as well as other works on alchemy and astronomy. Plato of Tivoli translated into Latin the Arabic version of the *Almagest* in 1138. Robert of Chester (c. 1144) had rendered the Qur'an into Latin and translated the *Algebra* of al-Khawarizmi. Alfred the Englishman (c. 1180) had translated from Arabic the corrupted peripatetic work on Plants.

## THE CRUSADES

As regards the Crusades, it is obvious that all that the Crusades brought to Europe was the culture of the Islamic East, because the only non-Christian people in contact with whom the youth of Christian Europe came during that period of continued warfare were the Muslims. It was thus both from the East and the West that Islamic culture paved the way for a Revival of Learning in Europe.

Dr. W. B. Stevenson says in the Chapter on "The Spirit and Influence of Crusades" in Volume 5 of *The Universal History of the World :*

> "The learning and art and science of the East, its public services and methods of government, its highly developed industries and the superior luxury and comfort of the domestic life of its upper classes, exerted a powerful and far-reaching influence upon Europe in the Crusading period".

And Again :

> "It should never be forgotten that the marvellous achievement of the Italian Renaissance followed directly in the train of the Crusading period. It may be said confidently that the Renaissance rested upon a foundation of material prosperity secured by the Crusades, and it may even be that its vital sparks were struck and kindled by the class of forces which the Crusades set in motion."

Dr. Henry Elmer Barnes, while summing up the consequences of the Crusades in Volume I of his *History of Western Civlization*, says :

"The Westerners learned many Muslim and Oriental ways and developed a taste for the luxuries of the region. All this promoted a demand for Eastern goods and accelerated the growth of commerce. The Italians, who had acted as transporting agents for the Crusaders, took full advantage of their opportunities to build up trading relations with the East. Travel was promoted, and the explorations of Marco Polo and others followed on the heels of Crusaders. This still further encouraged trade between Europe and the Orient. The revived trade promoted the rise of towns and a more progressive element in European life. The science and culture of the Muslims were brought back to Europe and helped to create the remarkable intellectual revival of the twelfth and thirteenth centuries."

George Sarton says :

"One of the results of the Crusades was the re-introduction of public bathing places in Europe, on the Muslim pattern. I say re-introduction, because the technique of bathing (cold and hot) had been carried very far by Romans and elaborate bathing places (belineae, thermae) obtained in all their important cities. However, that practice was discouraged by the Christians and disappeared entirely in the West during the disintegration of the Roman Empire......the Muslim peoples developed a new form of bathing, the hot steam-bath or hammam (from the Arabic root

"hamm," to heat). Arabic literature is full of references to it......Cruaders experienced these comforts in the East and introduced them into their own countries". (*Introduction to the History of Science.*)

## THE RENAISSANCE

We now come to the factors which are credited with having produced the Renaissance. These were (1) the recovery of Greek classics, (2) the diminution of ecclesiastical authority, (3) the discovery of America, and (4) the invention of the printing press.

## GREEK CLASSICS

The recovery of Greek classics is due to their preservation in an Arabic form. *The Historians' History* says of the Arabs:

"They merit eternal gratitude for having been the preservers of the learning of the Greeks and Hindus when those people were no longer producing anything and Europe was still too ignorant to undertake the charge of the precious depot. Efface the Arabs from History and the Renaissance of letters will be retarded in Europe by several centuries".

Dr. F. J. C. Hearnshaw says in his Chapter on 'European Life and Manners" in Volume 6 of the *Universal History of the World:*

"Christian students repaired to Islamic schools to learn the wisdom of the ancients and to gain the

secrets of those arts and crafts which made Mohamedan Spain famous throughout the world. It was by way of Spain that the long lost works of Aristotle reached Western Christendom to revolutionise scholastic Philosophy and Theology."

So also does Stanley Lane-Pool say in the Chapter on "Golden Age of Arab Culture" in the same book:

"What medieval Europe knew of Greek Philosophy, Mathematics, Chemistry, Astronomy and Medicine was learned principally through Latin translations from Arabic treatises which held their places in the schools of Europe down to the sixteenth and even well into the seventeenth century."

Similarly Max Kahn says in Chapter II on "History of Medicine in the Middle Ages" in Volume I of *The Practice of Medicine*:

"The Greek and Latin written contributions to Civilization were saved by the advent of the victorious Mohammedan armies into Europe, which carried in its wake the various educational and scientific influences that were to affect the whole course of European culture. The Saracens brought to Spain, under the protection of the banner of the crescent, the stored up treasures of an ancient learning. While church-ridden Europe reposed, ignorant of the wealth of knowledge and wisdom that the pagan writers had left as inheritance to civilization, the graceful Arabs and Moors interpolated their studies of the Koran

with readings from the Arabic translations of the Greek and Roman philosophers .... This tolerance of the Arabs was the saving grace of civilization. They relit the lamp of learning which had been extinguished in Europe, and the light of Hippocrates, Aristotle and Galen illumined the mosques and cloisters of the infidels. There science flourished, and there the art of medicine was given a new lease of progress."

And the Muslims not only preserved Greek learning, but also commented on it. They pointed out its errors and made a great progress over it. Many of the greatest blunders of Greek science were corrected by them. For example, Ibn al-Haitham for the first time proved that the rays originate in the object and not in the eyes when we see it.

## DIMINUTION ON ECCLESIASTICAL AUTHORITY

The other main factor that brought about the Renaissance was the diminution of the power of the Church and the emancipation of the individual in Europe. The old order, which existed there before Europe came in contact with the world of Islam, had been the empire of the Church, the commune, the guild, scholastic system: the individual was always part of some group, and no existence apart from it. The new order brought about after the Reformation, was the State, the national church, the merchant, the individual. The old order had as fundamentals

authority and asceticism: the new had reason and joy in the whole of life. For a thousand years there had been as much authority in social life as in intellectual.... Man used to be bound to a bishop, a lord, a municipality, to a school or a body. Now he proudly stepped on the stage as himself, eager to develop his capacities for his own benefit, with boundless confidence in his will, his superiority and his infinite variety". (Dr. R. H. Murray in the Chapter on "Luther and the Reformation" in Volume 6, of *The Universal History of the World.*)

Now this marvellous change in European life was brought about by Europe's contact with the followers of Islam during the Crusades. Says Earnest Barker in the Chapter on "The Crusades" in *The Legacy of Islam*:

> "The Crusades, if they did not remove, at any rate weakened the old clear distinction between sacred and profane, the lay and the clerical, the temporal and the spiritual; they were the consecration of the fighting layman, and in their way they led to the emancipation of the laity."

Henceforth, it may be claimed, "priestly orders no longer dominated men, and a new lay attitude of the world replaced the ecclesiastical attitude of the Middle Ages".

## DISCOVERY OF AMERICA

The discovery of America was made possible by the mariner's compass which was a Muslim invention.

Several centuries before Columbus the Arab sailors were using the valuable instrument which later on opened the way to all future navigation. It has been claimed that "the Chinese were probably the first to discover the directive property of the magnetic needle," yet the first practical use of the magnetic needle was credited by the Chinese themselves to foreigners, who were in all probability Muslims. Indeed maritime trade, according to Sarton "between the Far East on the one hand, and India, Persia, Arabia and Africa on the other was a Muslim monopoly".

The writings of Columbus contain clear references to the fact that the existence of a Western continent was suggested to him by a study of Ibn Rushd's work. Geographical works like those of al-Kindi on the sphericity of the Earth had well established the existence of land on the other side of the globe.

Ibn Khurdadbaih (d. 912-13) had stated in his famous work, *Kitab al-Masalik wal-Mamalik*, that the earth was spherical like a ball. Ibn Rusta, a writer of the ninth century A.D., also contended that the earth was a sphere. So also did Mas'udi say in his *Muruj-uz-Zahab*. Ibn Khurdadbaih wrote in his *Geography* that the other half of the earth which is underneath us was devoid of human habitation. This means that he accepted the view that there was land to be found on the other side of the globe.

An incontrovertible evidence of the American continent having come under Arab influence is the

fact that the languages of the American peoples contain many Arabic words, which had found their way in them long before Columbus discovered America. Even today, according to Maulana Sayyid Sulaiman Nadvi, an Arab tribe is said to be settled in Mexico, members of which speak the Arabic language (*Ma'arif*, Vol. XLV, No. 4.)

## INVENTION OF THE PRINTING PRESS

And, finally, as regards the invention of Printing, an event the results of which it is impossible to exaggerate, it may be observed that this invention was made possible by the manufacture of paper which was introduced into Europe by the Arabs (the first Islamic paper factory having been established in Baghdad in A.D. 794). Says H. G. Wells :

"The chief reason for this failure to develop printing systematically lies, no doubt, in the fact that there was no abundant supply of a uniform texture and convenient form. Had there been presses, they would have had to stand idle."

Abbott says in *The Expansion of Europe* :

"The material (paper) had entered Europe from the Orient with the coming of Arabs......Its peculiar adpatation to the new method of book-making combined with the use of the press and types to revolutionise the world, making an epoch in affairs more important even than the fall of Constantinople."

Another historian, who belongs to our own time,

Phillip K. Hitti, says in the *History of the Arabs*:

This accumulation of books in Andalusia would not have been possible but for the local manufacture of writing-paper, one of the most beneficial contributions of Islam to Europe. Without paper, printing from movable type, which was invented in Germany about the middle of the fifteenth century, would not have been successful, and without paper and printing popular education in Europe, on the scale to which it developed, would not have been feasible."

It would be interesting at this place to note the development of the word ream so often used in connection with paper. Hitti says:

"(The English word) 'ream' is derived through Old French 'rayme' from Spanish 'resma', a loan-word from Arabic 'rismah', a bundle."

The Renaissance was thus brought about under the direct influence of Islamic culture.

## EUROPE'S OBLIGATIONS TO ISLAM

Draper observes:

"I have to deplore the systematic manner in which the literature of Europe has contrived to put out of sight our scientific obligations to the Mohammedans. Surely they cannot be much longer hidden. Injustice founded on religious rancour and national conceit cannot be perpetuated for ever. What should the modern astronomer say, when, remembering the contemporary barbarism

of Europe, he finds the Arab Abul Hassen speaking of tubes, to the extremities of which ocular and object diopters, perhaps sights, were attached, as used at Meragha? What, when he reads of the attempts of Abdulrahman Sufi at improving the photometry of the stars? Are the astronomical tables of Ebn Junis (A.D. 1000), called the Hakemite tables, or the Ilkanic tables of Nassar Eddin Tusi, constructed at the great observatory just mentioned, Meragha near Tauris (A.D. 1259), or the measurement of time by pendulum oscillations, and the methods of correcting astronomical tables by systematic observations are such things worthless indications of the mental state? The Arab has left his intellectual impress on Europe, as, before long, Christendom will have to confess; he has indelibly written it on the heavens, as any one may see who reads the names of the stars on a common celestial globe. (*History of the Intellectual Development of Europe*).

## EXTRAORDINARY RELIGION

In the end with Scott, the eminent author of the *History of Moorish Empire in Spain*, "we may well consider with admiration the rapid progress and enduring effects of this extraordinary religion which everywhere brought order, wealth and happiness in its train......which fastened the graceful arches of our cathedrals, which placed its seal upon the earth in the measurement of a degree, and inscribed its

character in living light amidst the glittering constellations of the earth; which has left its traces in the most familiar terms of languages of Europe; which affords daily proof of its beneficent office in the garments that we wear, in the books that we read, in the grains of our hearths, in the fruits of our orchards, in the flowers of our gardens; and which gave rise to successive dynasties of sovereigns, whose supreme ambition seemed to be to exalt the character of their subjects, to transmit unimpaired to posterity the inestimable treasures of knowledge, and to extend and perpetuate the intellectual empire of Man."

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